## ABSTRACT OF THE INVENTION

Thermal neutron absorbing composite coating materials and methods of applying such coating materials to spent nuclear fuel storage systems are provided. A composite neutron absorbing coating applied to a substrate surface includes a neutron absorbing layer overlying at least a portion of the substrate surface, and a corrosion resistant top coat layer overlying at least a portion of the neutron absorbing layer. An optional bond coat layer can be formed on the substrate surface prior to forming the neutron absorbing layer. The neutron absorbing layer can include a neutron absorbing material, such as gadolinium oxide or gadolinium phosphate, dispersed in a metal alloy matrix. The coating layers may be formed by a plasma spray process or a high velocity oxygen fuel process.